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PATENT APPLICATION

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Patent Application Transmittal Letter

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Transmitted herewith for filing under 37 CFR 1.53(b) is a(n): ☒ Utility ☐ Design

☒ original patent application,

☐ continuation-in-part application

INVENTOR(S): Akio Yamamoto

TITLE: Producing Engraving-Style Halftone Images

Enclosed are:

- ☒ The Declaration and Power of Attorney. ☐ signed ☒ unsigned or partially signed  
☒ 8 sheets of drawings (one set) ☐ Associate Power of Attorney  
☐ Form PTO-1449 ☒ Information Disclosure Statement and Form PTO-1449  
☒ Priority document(s) ☐ (Other) (fee \$ )

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INDEPENDENT CLAIMS	3 — 3	0	X \$78	\$ 0
ANY MULTIPLE DEPENDENT CLAIMS	0		\$260	\$ 0
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By Dee Timmons  
Typed Name: Dee Timmons

Respectfully submitted,

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**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

This is a U.S. Patent Application for:

Title: **PRODUCING ENGRAVING-STYLE HALFTONE IMAGES**

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Citizenship: **Japan**

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**Dee Timmons**

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(Signature of person mailing paper or fee)

\_\_\_\_\_  
(Date signed)

# **PRODUCING ENGRAVING-STYLE HALFTONE IMAGES**

## **CROSS-REFERENCE TO RELATED APPLICATIONS**

Under 35 U.S.C. § 119, this application claims the benefit of Japanese Patent Application No. 11.256084, filed August 6, 1999, by Akio Yamamoto, and  
5 entitled "Method for Producing Engraving-Style Halftone Images," which is incorporated herein by reference.

## **TECHNICAL FIELD**

This invention relates to digital image processing and, more particularly, to systems and methods for producing engraving-style halftone images.

## **BACKGROUND**

Digital images are formed from an array of pixels (picture elements), each pixel having an assigned color and intensity. Digital images may be processed in a variety of different ways to achieve any number of desired effects.

For example, digital images may be processed to conform to the format of  
15 a particular output device (e.g., a printer or plotter). Typically, an image must be converted into a halftone image before it may be printed by an output device. Halftoning is the process of breaking down a continuous tone image into solid spots of differing sizes to create the illusion of transitioning grays or colors in a printed image. Halftones may be created by different methods, including error  
20 diffusion, dot pattern, random dither and ordered dithered methods. Each halftone processing method involves converting continuous tone image data into a plurality of binary halftone dots with a density gradation that is similar to that of the original continuous tone image.

Digital images also may be processed to alter their appearance. For  
25 example, a digital image may be filtered to add one or more different effects, including fine arts and hand drawn effects, impressionistic and mosaic effects, noise effects, lighting effects, and distortion effects. Adobe™ Photoshop™ (available from Adobe Systems, Incorporated of San Jose, California) provides a halftone pattern filter that applies halftone line pattern effects to an image. Other  
30 appearance-altering digital image processing techniques are known.

## SUMMARY

The invention provides an image processing scheme that applies engraving-style effects to an image. In particular, the invention applies halftone line pattern effects to an image in a manner that preserves sufficient contrast information from the original image that a true engraving-style image may be produced. The resulting image has a digital engraving effect that simulates a classic old world engraving.

In one aspect, the invention features an image processing scheme (system and method) in accordance with which an initial line pattern is warped to produce a warped line pattern, and an original image is mapped onto the warped line pattern to produce an engraving-style halftone image.

Embodiments of the invention may include one or more of the following features.

The initial line pattern preferably is warped based upon pixel values of the original image. The initial line pattern may be oriented substantially along an initial direction and the initial line pattern is warped in a direction substantially orthogonal to the initial direction. In one embodiment, the initial line pattern is warped based upon a density map extracted from pixel values of the original image. A density map may be produced by sampling pixel values of the original image. In another embodiment, the initial line pattern is warped based upon gradient information computed from pixel values of the original image. The gradient information for a pixel location may be computed based upon a weighted averaging of gradient information computed from neighboring pixel values. The initial line pattern preferably is warped based upon a set of displacement values computed for pixel locations along each line of the initial line pattern. The initial line pattern also preferably is warped by inserting or removing one or more lines between adjacent lines of the initial line pattern.

The original image preferably is mapped onto the warped line pattern based upon a comparison of original image pixel values and warped line pattern pixel values. For example, the original image may be mapped onto the warped line pattern by producing black pixel values of the engraving-style image at pixel locations where original image pixel values are less than corresponding warped line pattern pixel values, and producing white pixel values of the engraving-style

image at pixel locations where original pixel values are greater than or equal to corresponding warped line pattern pixel values.

In another aspect, the invention features a computer readable medium carrying instructions for implementing the above-described image processing  
5 scheme.

Among the advantages of the invention are the following.

The invention enables a true three-dimensional engraving-style image to be produced from a continuous tone image. In addition, because the resulting engraving-style image may be formed from a series of continuous pixel data in the  
10 scanning direction, run-length data compression methods may be used to compress the engraving-style image data with a high compression ratio. This feature improves the speed at which the image data may be transmitted, for example, by facsimile.

Other features and advantages of the invention will become apparent from  
15 the following description, including the drawings and the claims.

### **DESCRIPTION OF DRAWINGS**

FIG. 1 is a block diagram of an image processor producing an engraving-style image from an original image.

FIG. 2A is a front view of the original image of FIG. 1.

FIG. 2B is a front view of the engraving-style image of FIG. 1.

FIG. 3 is a block diagram of the image processor of FIG. 1.

FIG. 4 is a flow diagram of an image processing method.

FIG. 5 is a flow diagram of an image processing method.

FIG. 6A is a diagrammatic view of an original image over which an  
25 analysis line is being scanned.

FIG. 6B is a plot of pixel shading values along the analysis line of FIG. 6A.

FIG. 6C is a front view of a density map generated from the original image of FIG. 2A.

FIG. 7A is a diagrammatic view of a search window applied over a region  
30 of the density map of FIG. 6C.

FIG. 7B is a plot of displacement values corresponding to halftone dots within the search window of FIG. 7A.

FIG. 8 is a front view of warping control points generated by displacing the lattice pixel locations in accordance with their corresponding warping displacement values.

FIG. 9 is a front view of a warped line pattern produced by inserting a plurality of spline interpolation pixels between adjacent lines of the line pattern of FIG. 8.

FIG. 10 is a block diagram of a lattice pixel and a plurality of surrounding neighboring pixels in a region of the original image of FIG. 1.

### DETAILED DESCRIPTION

Referring to FIGS. 1, 2A and 2B, in one embodiment, an image processor 10 is configured to process an original image 12 (FIG. 2A) to produce an engraving-style image 13 (FIG. 2B). Original image 12 may be a continuous tone image, a multi-tone image or a halftone image. In addition, original image 12 may be a color image or a grayscale image. In the present embodiment, original image 12 is a 8-bit grayscale image formed from an 512 x 512 array of pixels with a resolution of 300 dpi. The resulting engraving-style image 13 preferably is a halftone image having a three-dimensional digital engraving effect that simulates a classic old world engraving. In particular, engraving-style image 13 substantially preserves three-dimensional information contained in original image 12 to produce realistic engraving-style effects.

Referring to FIG. 3, in one embodiment, image processor 10 includes a processing unit 14, a system memory 16, and a system bus 18 that couples processing unit 14 to the various components of image processor 10. Processing unit 14 may include one or more processors, each of which may be in the form of any one of various commercially available processors. System memory 16 includes a read only memory (ROM) 20 that stores a basic input/output system (BIOS) containing start-up routines for image processor 10, and a random access memory (RAM) 22. System bus 18 may be a memory bus, a peripheral bus or a local bus, and may be compatible with any of a variety of bus protocols, including PCI, VESA, Microchannel, ISA, and EISA. Image processor 10 also includes a hard drive 24, a floppy drive 26, and CD ROM drive 28 that are connected to system bus 18 by respective interfaces 30, 32, 34. Hard drive 24, floppy drive 26

and CD ROM drive 28 contain respective computer-readable media disks 36, 38, 40 that provide non-volatile storage for data, data structures and computer-executable instructions. Other computer-readable storage devices (e.g., magnetic tape drives, flash memory devices, and digital video disks) also may be used with image processor 10. A user may interact (e.g., enter commands or data) with image processor 10 using a keyboard 42 and a mouse 44. Other input devices (e.g., a microphone, joystick, or touch pad) also may be provided. Information may be displayed to the user on a monitor 46. Image processor 10 also may include peripheral output devices, such as speakers, a printer, and a scanner. Image processor 10 may communicate with remote computers 48 over a wide area network (WAN) (e.g., the Internet) 50, and may communicate with network computers 52 over a local area network (LAN) 54. Remote computers 48 and network computers 52 may be workstations, image processors, routers, peer devices or other common network nodes.

As shown in FIG. 4, in general, image processor 10 produces engraving-style image 13 by warping an initial line pattern (step 60), and mapping original image 12 onto the warped line pattern (step 62).

Referring to FIG. 5, in one particular image processing embodiment, image processor 10 produces engraving-style image 13 from original image 12 as follows.

Image processor 10 first reads original image 12 (step 70). Original image 12 may be a photograph, in which case original image 12 may be read by a scanner (e.g., an HP ScanJet® scanner available from Hewlett-Packard Company of Palo Alto, California), and the resulting digital image may be stored in any one of a variety of raster formats (e.g., GIF, PCX or TIFF). Alternatively, original image 12 may be a digital image (e.g., produced by a scanner or a digital camera), in which case original image 12 simply may be retrieved from the image storage location (e.g., media disks 30-34 of hard drive 24, floppy drive 26 or CD ROM drive 40).

Referring to FIGS. 6A-6C, after reading the image data, image processor 10 extracts a density map 74 (FIG. 6C) from original image 12 (step 72). To produce density map 74, image processor scans an analysis line 76, which is oriented along an analysis axis 78, across original image 12 in a scanning direction 80. The pixel shading (or darkness) values along analysis line 76 is simulated in density map 74 by a plurality of halftone dots (represented by "x" in FIG. 6B).

The halftone dots are arranged according to the original image gray level distribution of shading values along analysis axis 76. That is, the density of halftone dots tracks the shading of original image 12 so that the dot density is relatively high in darker regions of original image 12 and is relatively low in lighter regions of original image 12. The halftone dots are spaced apart in accordance with the magnitude of gray level distribution curve 82 along analysis line 76. The halftone dot spacing is small in a relatively dark region 84, medium in a medium intensity region 86, and large in a relatively bright region 88 of original image 12. The relative halftone dot spacing is selected to track the local gray level of original image 12 by spacing the halftone dots so that the area under gray level distribution curve 82 between any two adjacent halftone dots is substantially the same. Thus, the areas under gray level distribution curve 82 in zones 90, 92 and 94 – which are defined between adjacent pixels in mid-density region 86, high density region 84 and low density region 88, respectively – are the substantially the same.

Density map 74 may be produced by sampling pixel values of original image 12. The sampling rates in the analysis direction 78 and in the scanning direction may be the same or different. In the present embodiment, density map 74 is generated by sampling original image 12 at a rate of 1/3 in the analysis direction 78 and at a rate of 1/3 in the scanning direction 80.

Referring back to FIG. 5 and to FIGS. 7A and 7B, warping control points are computed based upon the vertical distribution of halftone dots in density map 74 as follows (step 100). A search window 102 is centered around a pixel 104 of density map 74. In one embodiment, search window 102 encompasses a vertical array of pixels that is 1 pixel wide and  $2b + 1$  pixels long, where  $b$  is an integer. In the present embodiment, search window 102 encompasses a  $1 \times 11$  pixel array (i.e.,  $b = 5$ ). The spacing between the halftone dots within search window 102 and pixel 104 are summed to obtain a warping displacement value for the location of pixel 104. Thus, the warping displacement value ( $d$ ) for the location of pixel 104 may be computed as follows:

$$d = (-5) + (-3) + (-1) + 3 + 4 = -2 \quad (1)$$



which corresponds to a vertical displacement of two pixel locations above pixel 104. Search window 102 may be scanned across density map 74 to obtain a set of warping displacement values corresponding to a set of lattice pixel locations. In particular, warping displacement values preferably are computed for lattice pixels  
5 located at the intersections of a series of space apart horizontal scan lines and a series of spaced apart vertical lines. As used herein, the term "lattice pixel location" refers to the pixel locations at the intersections of the horizontal and vertical scan lines. Search window 102 preferably is scanned across density map 74 along horizontal scan lines in non-overlapping scan zones. For example, in  
10 the present embodiment, adjacent scan lines are spaced apart by ten (i.e.,  $2 \cdot b$ ) pixels, resulting in a total of fifty-three scan lines (i.e.,  $512/10 = 51.2$  plus two boundary scan lines). In other embodiments, the number and, consequently, the spacing between horizontal scan lines may be different. The spacing between the vertical scan lines also may vary. In the present embodiment, the vertical scan  
15 lines are spaced apart by thirty pixels, resulting in nineteen vertical scan lines (i.e.,  $512/30 = 17.1$  plus two boundary scan lines). A set of warping control points is generated by displacing the lattice pixel locations in accordance with their corresponding warping displacement values.

Referring back to FIG. 5, if an initial line pattern has not been generated  
20 (step 106), the initial line pattern is generated (step 108). The initial line pattern preferably consists of a plurality of lines. The number, width and rate of change in the shading of the lines may be varied as desired. In the present embodiment, the width of each line of the initial line pattern is one and the number of lines coincides with the number of horizontal scan lines of the original image. The  
25 lines may consist of a set of parallel lines that are oriented along a preferred direction (e.g., horizontally, vertically or diagonally). Alternatively, the lines may consist of a set of curved lines produced by projecting a set of parallel straight lines over a three dimensional object (e.g., a cylinder or a sphere). The total number of pixels in the initial line pattern preferably is equal to the number  
30 of pixels in original image 12 (e.g.,  $512 \times 512$ ).

The initial line pattern is warped based upon the computed warping control points 111 (step 110). In one embodiment, the initial line pattern is mesh warped based upon horizontal and vertical spline interpolation (see, e.g., George

Wolberg, "Digital Image Warping," IEEE Computer Society Press (1990)).

Referring to FIG. 8, the initial line pattern is warped by horizontal spline interpolation as follows. With respect to the present embodiment, each of the fifty-three horizontal lines of the initial line pattern that are the horizontal scan lines of the lattice pixels is spline interpolated to the corresponding nineteen warping control points to produce a horizontally warped line pattern that consists of a series of smooth, horizontally oriented curved lines. Referring to FIG. 9, the horizontally warped line pattern is further warped by vertical spline interpolation to insert additional pixels or to remove excessive pixels between the lines of horizontally warped line pattern. Spline interpolation techniques may be used to compute the locations of the additional pixels to be inserted or the locations of the excessive pixels to be removed between each pair of vertically spaced apart pixels of the lines of horizontally warped line pattern. As shown in FIG. 9, the vertical spacing between the lines of the resulting warped line pattern 112 substantially tracks the vertical spacing between the lines of the horizontally warped line pattern.

In general, the warping process produces a series of warped lines defined by real number coordinates. Thus, to determine the appropriate brightness values of the real number coordinates, a conversion table mapping the integer coordinates of the initial line pattern to the real number coordinates of the warped line pattern 112 must be generated. This conversion table is produced by weighted averaging according to the distance between real number coordinates and integer coordinates.

If it has not been preprocessed (step 113), the original image is preprocessed (step 114). Preprocessing includes filtering (e.g., low pass filtering to smooth minute changes in brightness) and contrast highlighting to increase the contrast in the image. Other conventional preprocessing techniques also may be applied to the original image.

The original image is mapped onto the horizontally and vertically warped line pattern 112 (step 116). The mapping process is threshold-based, and involves comparing the brightness of original image pixel values to the brightness of corresponding pixels of warped line pattern 112. The result of the mapping process is engraving-style halftone image 13, in which pixels are black at

locations where the brightness of original image 12 is less than the brightness of warped line pattern 112, and pixels are white at locations where the brightness of original image 12 is greater than or equal to the brightness of warped line pattern 112.

5           The resulting engraving-style halftone image 13 may be written to a storage medium or sent to an output device (e.g., a printer or plotter) for printing (step 118).

Other embodiments are within the scope of the claims.

For example, density map generation step 72 in the above-described image  
10   processing embodiment may be eliminated, and the warping control points may be computed directly based upon gradient information extracted from the pixel values of original image 12 as follows. Referring to FIG. 10, gradient information is extracted for a lattice pixel location (A) based upon the relative pixel values of neighboring pixels. In particular, the shading gradient for a lattice pixel location  
15   A may be expressed as follows:

$$\nabla A(x, y) = (\delta A / \delta x, \delta A / \delta y) \quad (2)$$

The magnitude ( $G_{\text{mag}}(x, y)$ ) and orientation ( $G_{\text{dir}}(x, y)$ ) of the shading  
20   gradient may be computed from the following equations:

$$G_{\text{mag}}(x, y) = [(\delta A / \delta x)^2 + (\delta A / \delta y)^2]^{1/2} \quad (3)$$

$$G_{\text{dir}}(x, y) = \tan^{-1}[(\delta A / \delta x) / (\delta A / \delta y)] \quad (4)$$

25   The number of neighboring pixels from which the gradient information is computed may vary. In one embodiment, the lattice pixel and the neighboring pixels form a 9 x 29 pixel array. As shown in FIG. 10, in another embodiment, a 5 x 5 pixel array may be used to compute the gradient information. Warping displacement values may be computed from equations (3) and (4). In particular,  
30   the warping displacement magnitude ( $V_{\text{mag}}(x, y)$ ) and the warping displacement direction ( $V_{\text{dir}}(x, y)$ ) may be computed from the following equations:

$$V\_mag(x, y) = \sum_{j=-2}^2 \sum_{i=-2}^2 w\_mag(i, j) \cdot G\_mag(x-i, y-j) \quad (5)$$

$$V\_dir(x, y) = \sum_{j=-2}^2 \sum_{i=-2}^2 w\_dir(i, j) \cdot G\_dir(x-i, y-j) \quad (4)$$

where  $w\_mag(i, j)$  and  $w\_dir(i, j)$  are weighting coefficients for pixel values  
 5 displaced from the lattice pixel location (A) by  $i$  pixels in the x-direction and  $j$   
 pixels in the y-direction. The values of all of the weighting coefficients preferably  
 add up to one. In addition, the values of the weighting coefficients preferably are  
 larger for nearby pixel neighbors than for more distant pixel neighbors. For  
 example, in the present embodiment, the weighting coefficient for the lattice pixel  
 10 A is  $\frac{1}{2}$ , the weighting coefficient for each of the eight nearest neighbors (i.e.,  $(i, j)$   
 $= \{(-1, -1), (-1, 0), (-1, 1), (0, -1), (0, 1), (1, -1), (1, 0), (1, 1)\}$ ) is  $1/32$ , and the  
 weighting coefficient for each of the remaining sixteen neighbors is  $1/64$ . In this  
 example,  $w\_mag(i, j) = w\_dir(i, j)$ . In other embodiments, however, the  
 magnitude and direction weighting coefficients may be different. The warping  
 15 control points may be determined from the direction and amount of displacement  
 from each lattice point using  $V\_mag(x, y)$  and  $V\_dir(x, y)$ .

The systems and methods described herein are not limited to any particular  
 hardware or software configuration, but rather they may be implemented in any  
 computing or processing environment. Image processor 10 preferably is  
 20 implemented in a high level procedural or object oriented programming language;  
 however, the program may be implemented in assembly or machine language, if  
 desired. In any case, the programming language may be a compiled or  
 interpreted language.

Still other embodiments are within the scope of the claims.



11. The method of claim 10, wherein the original image is mapped onto the warped line pattern by producing black pixel values of the engraving-style image at pixel locations where original image pixel values are less than corresponding warped line pattern pixel values, and producing white pixel values of the engraving-style image at pixel locations where original pixel values are greater than or equal to corresponding warped line pattern pixel values.

1           12.    An image processing system, comprising a processor programmed to  
2   warp an initial line pattern to produce a warped line pattern, and to map an  
3   original image onto the warped line pattern to produce an engraving-style  
4   halftone image.

1           13.    The system of claim 12, wherein the initial line pattern is warped  
2    based upon a density map extracted from pixel values of the original image.

1           14.    The system of claim 13, wherein the processor is programmed to  
2   produce a density map by sampling pixel values of the original image.

1           15.    The system of claim 12, wherein the initial line pattern is warped  
2    based upon gradient information computed from pixel values of the original  
3    image.

1           16.    The system of claim 15, wherein the processor is programmed to  
2   compute gradient information for a pixel location based upon a weighted  
3   averaging of gradient information computed from neighboring pixel values.

1           17.     The system of claim 12, wherein the initial line pattern is warped  
2     based upon a set of displacement values computed for pixel locations along each  
3     line of the initial line pattern.

1           18.     The system of claim 12, wherein the initial line pattern is warped by  
2     inserting or removing one or more lines between adjacent lines of the initial line  
3     pattern.



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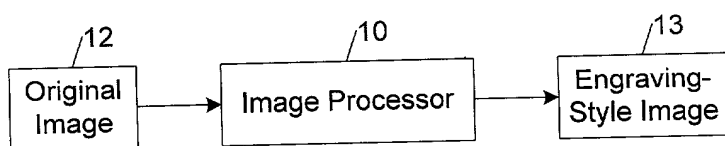


FIG. 1



FIG. 2A



FIG. 2B

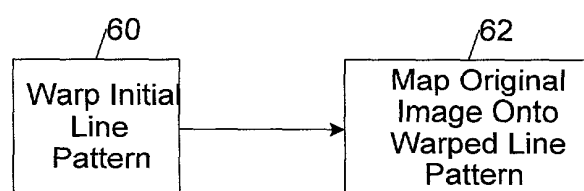


FIG. 4

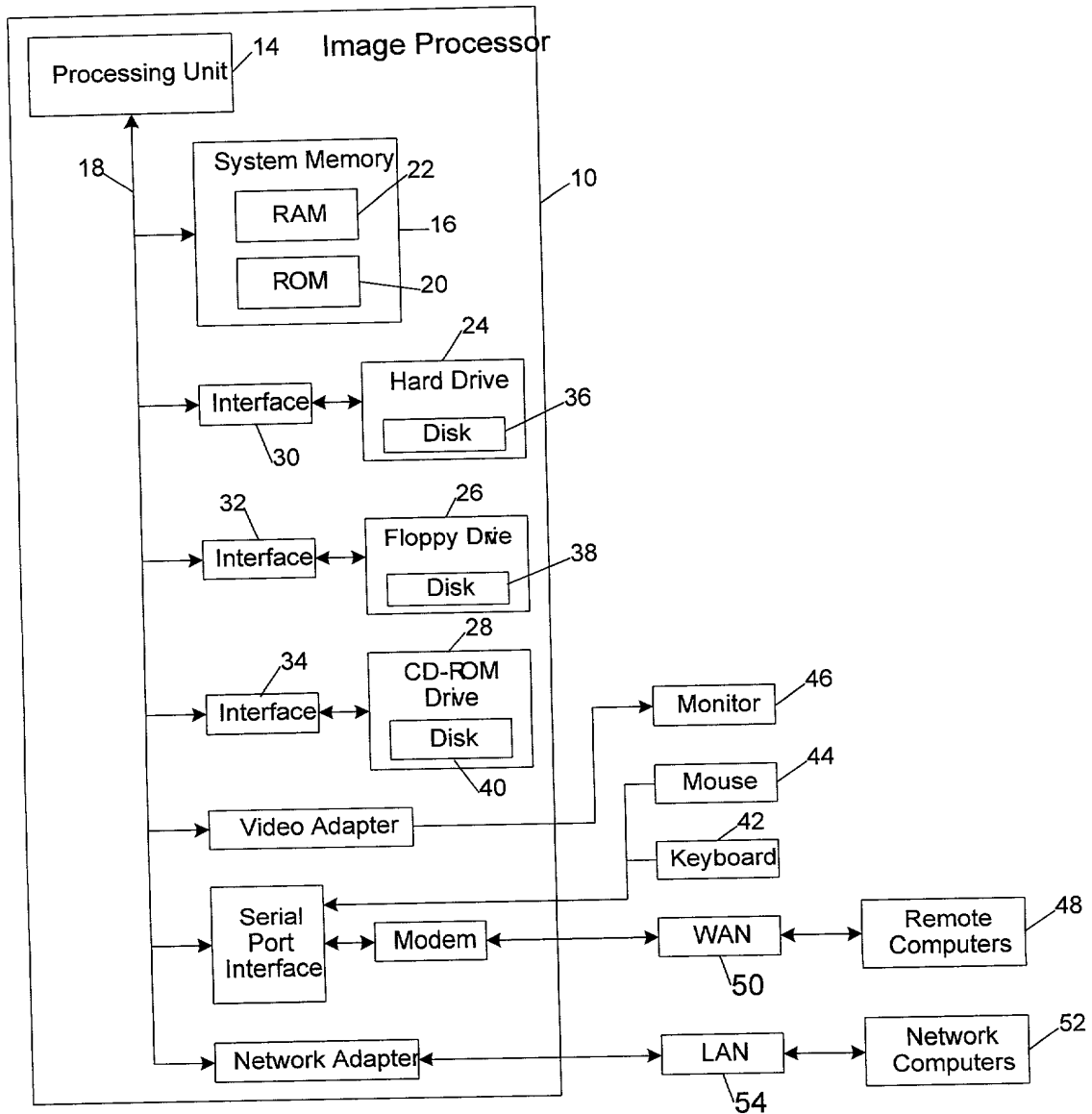


FIG. 3

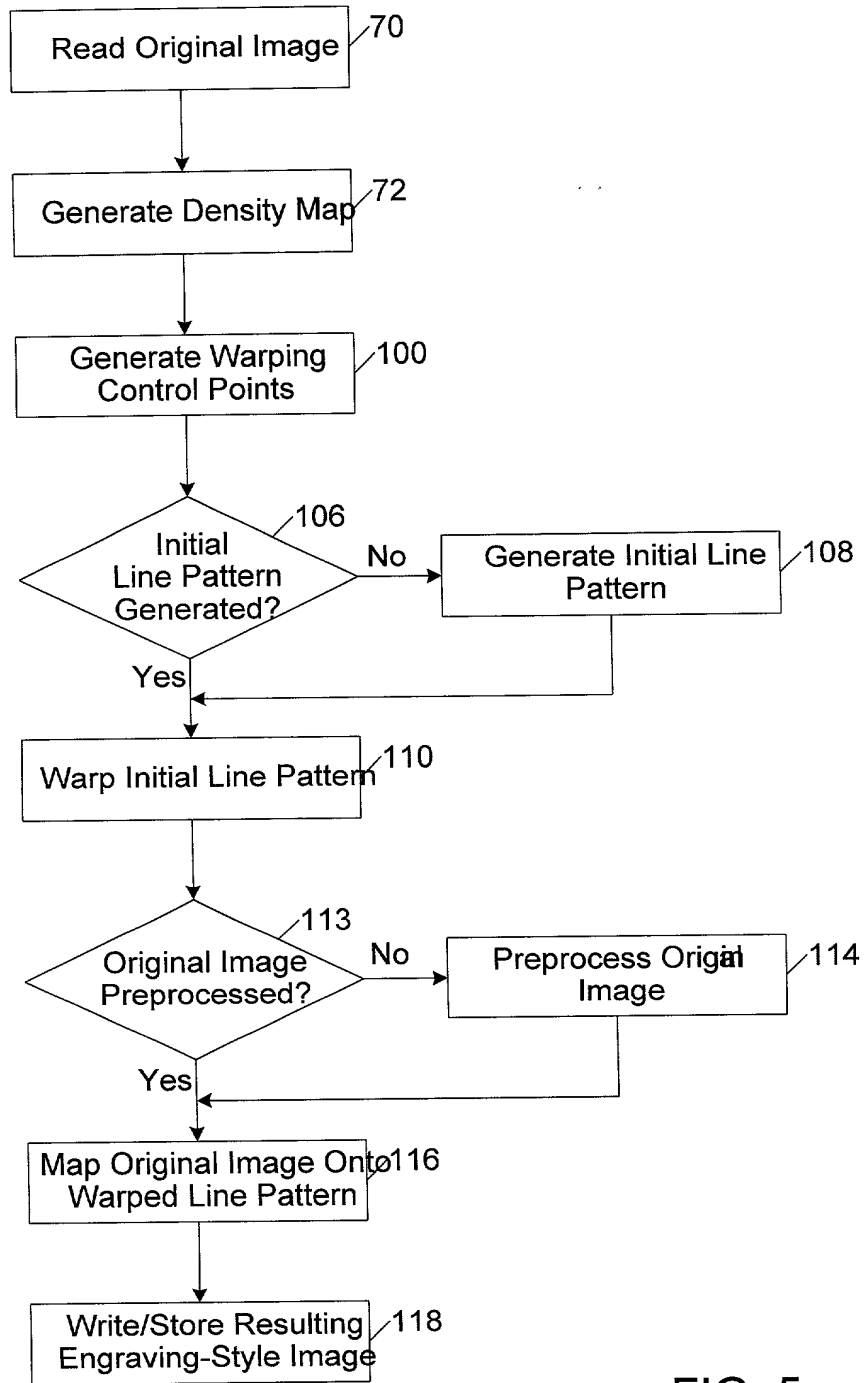


FIG. 5

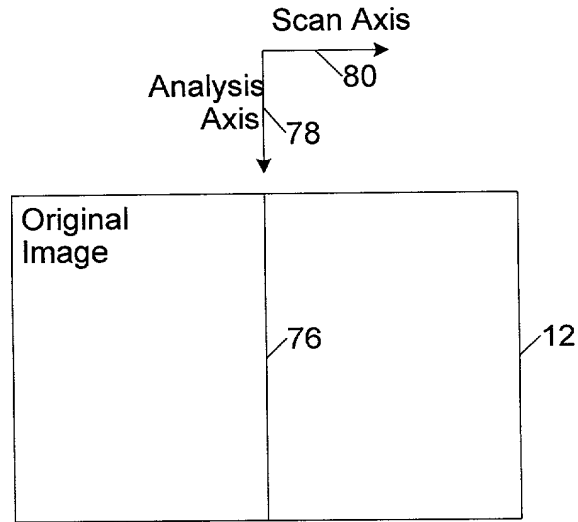


FIG. 6A

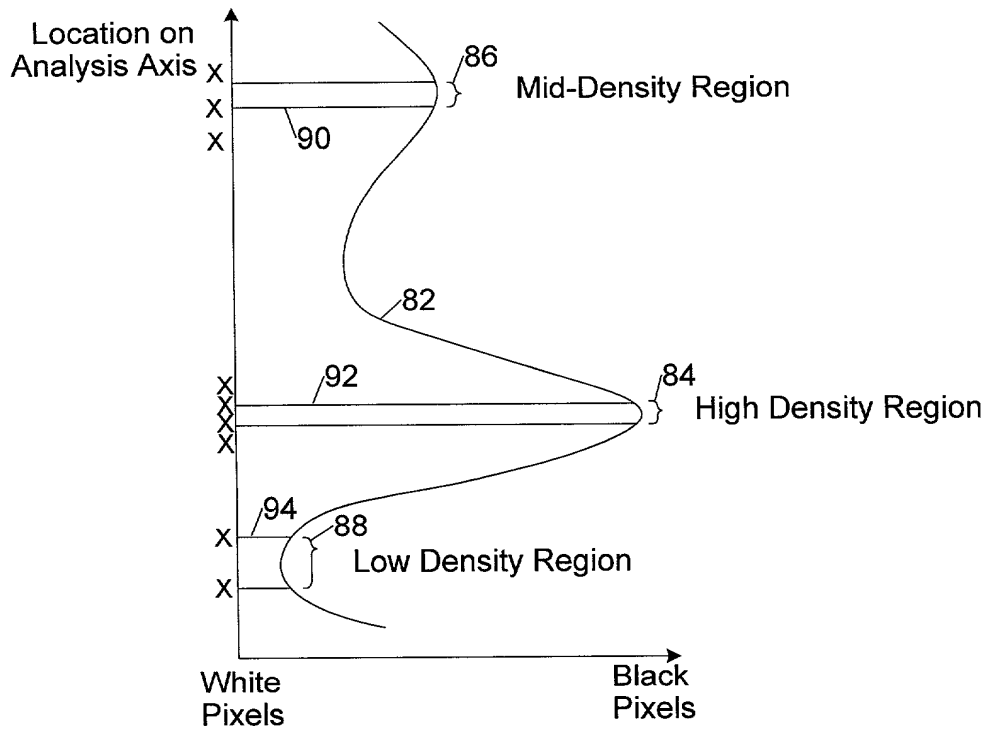


FIG. 6B



FIG. 6C

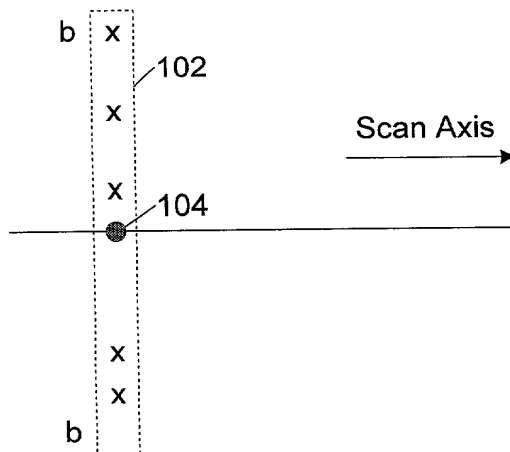


FIG. 7A

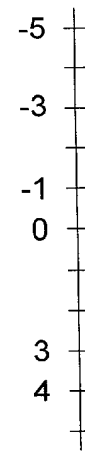


FIG. 7B



FIG. 8

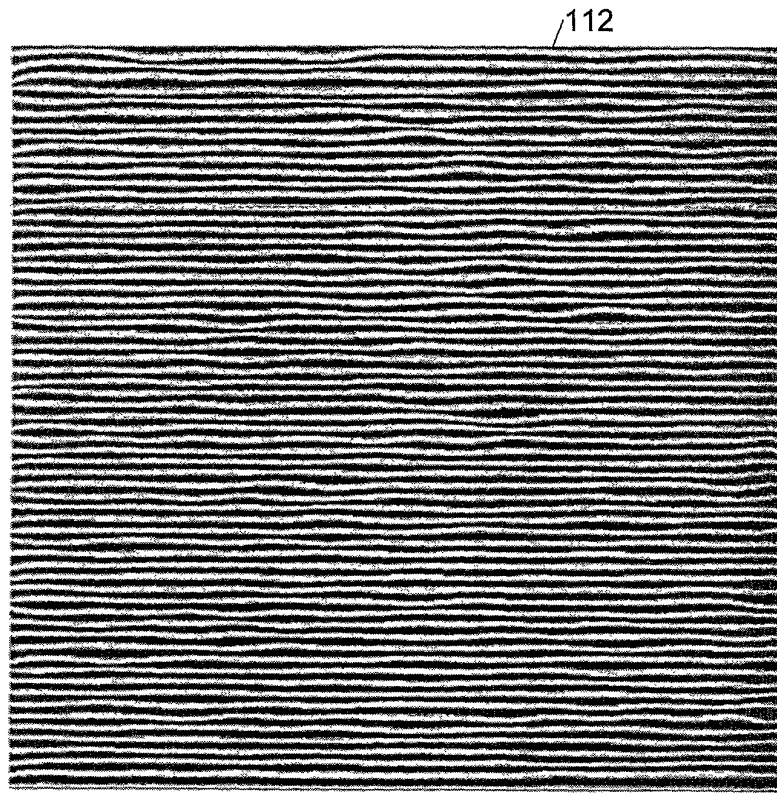


FIG. 9

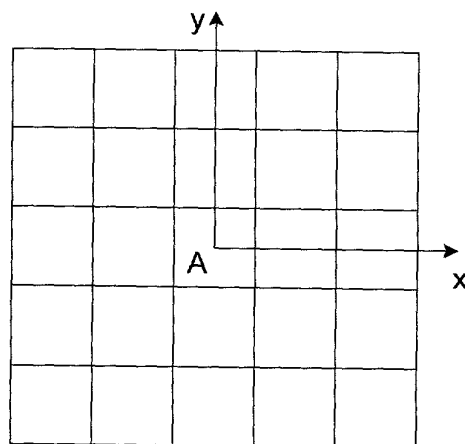


FIG. 10



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## Declaration and Power of Attorney For Patent Application

特許出願宣言書及び委任状

### Japanese Language Declaration

#### 日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者であると（下記の名称が複数の場合）信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

#### Producing Engraving-Style

#### Halftone Images

上記発明の明細書（下記の欄でx印がついていない場合は、本書に添付）は、

the specification of which is attached hereto unless the following box is checked:

☐ 月 日に提出され、米国出願番号または特許協定条約国際出願番号を \_\_\_\_\_ とし、  
（該当する場合） \_\_\_\_\_ に訂正されました。

☐ was filed on \_\_\_\_\_  
as United States Application Number or  
PCT International Application Number  
\_\_\_\_\_ and was amended on  
\_\_\_\_\_ (if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

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### Prior Foreign Application(s)

外国での先行出願

11-3095412

(Number)  
(番号)

Japan

(Country)  
(国名)

(Number)  
(番号)

(Country)  
(国名)

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I hereby claim foreign priority under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Priority Not Claimed

優先権主張なし

08/06/99

(Day/Month/Year Filed)  
(出願年月日)

☐

(Day/Month/Year Filed)  
(出願年月日)

☐

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.)  
(出願番号)

(Filing Date)  
(出願日)

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of application.

(Status Patented, Pending, Abandoned)  
(現況：特許許可済、係属中、放棄済)

(Status Patented, Pending, Abandoned)  
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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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**Japanese Language Declaration**  
(日本語宣言書)

委任状： 私は下記の発明者として、本出願に関する一切の  
手続きを米特許商標局に対して遂行する弁理士または代理人  
として、下記の者を指名いたします。(弁護士、または代理  
人の氏名及び登録番号を明記のこと)

**POWER OF ATTORNEY:** As a named inventor, I hereby appoint  
the following attorney(s) and/or agent(s) to prosecute this  
application and transact all business in the Patent and Trademark  
Office connected therewith (list name and registration number)  
**James W. Maccoun, Reg. No. 35,592**

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(第三以降の共同発明者についても同様に記載し、署名をす  
ること)

(Supply similar information and signature for third and subsequent  
joint inventors.)